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Effects of multiple interventions for reducing vocal stereotypy: Developing a sequential intervention model

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ABSTRACT

Despite the availability of several interventions designed to reduce engagement in vocal stereotypy, few studies have compared two or more interventions together. Consequently, practitioners have limited amount of data to make informed decisions on whether an intervention may be more suitable than another to begin treating vocal stereotypy. The purpose of the study was to address this limitation by examining the direct and collateral effects of multiple interventions in 12 individuals with autism and other developmental disabilities in order to guide the development of a sequential intervention model. Using single-case experimental designs, we conducted a series of four experiments which showed that (a) noncontingent music generally produced more desirable outcomes than differential reinforcement of alternative behavior, (b) differential reinforcement of other behavior reduced vocal stereotypy in two participants for whom noncontingent music had failed to do so, (c) the addition of simple prompting procedures may enhance the effects of the interventions, and (d) the effects of noncontingent music may persist during sessions with extended durations. Based on these results, we propose a sequential intervention model to facilitate the initial and subsequent selection of an intervention most likely to reduce vocal stereotypy while producing desired collateral outcomes.

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1. Introduction

Individuals with autism spectrum disorders often engage in various forms of vocal stereotypy (e.g., repeating previously heard words, producing meaningless sounds), which may be disruptive to others and interfere with social inclusion (Lanovaz & Sladeczek, 2012; MacDonald et al., 2007; Matson, Dempsey, & Fodstad, 2009; Mayes & Calhoun, 2011). Response interruption and redirection (RIRD; e.g., Ahearn, Clark, MacDonald, & Chung, 2007; Schumacher & Rapp, 2011), response cost (e.g., Falcomata, Roane, Hovanetz, Kettering, & Keeney, 2004; Watkins & Rapp, 2014), noncontingent music (e.g., Lanovaz & Sladeczek, 2011; Saylor, Sidener, Reeve, Fetherston, & Progar, 2012), and differential reinforcement of other behavior (DRO; Rozenblat, Brown, Brown, Reeve, & Reeve, 2009; Taylor, Hoch, & Weissman, 2005) are examples of interventions that have amassed varying levels of empirical support for the treatment of vocal stereotypy in the research literature. Despite the availability of several interventions, few studies have compared two or more interventions together (Shabani & Lam, 2013).

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Consequently, practitioners have limited amount of data to make informed decisions on whether an intervention may be more suitable than another to begin treating vocal stereotypy.

In a notable exception, Love, Miguel, Fernand, and LaBrie (2012) compared the effects of RIRD and noncontingent access to toys that produce auditory stimulation on engagement in vocal stereotypy and appropriate vocalizations in two school-aged boys with autism. Their results indicated that both interventions reduced vocal stereotypy to similar levels, but that RIRD produced larger increases in appropriate vocalizations. One of the main strengths of the study was that the researchers measured the effects of the intervention on other behavior. Measuring vocal stereotypy alone would have indicated that both interventions were equally effective whereas considering the appropriate vocalizations suggested that RIRD produced a more desirable outcome. In some settings, individuals with developmental disabilities may be expected to engage in alternative behavior other than appropriate vocalizations. For example, the vocalizations may be disruptive to others (e.g., classmates, colleagues) or interfere with other alternative behavior (e.g., completing a task). Then again, other individuals may be unavailable to respond to the appropriate vocalizations. Practitioners should also note that RIRD often requires the ongoing implementation of a punishment contingency (e.g., Carroll & Kodak, in press; Cassella, Sidener, Sidener, & Progar, 2011), which may be challenging in certain settings or when the contingent demands evoke aggressive behavior.

Two interventions that may be appropriate alternatives in such settings are noncontingent access to music and differential reinforcement of alternative behavior (DRA). Noncontingent music involves playing preferred music continuously through external speakers or headphones (e.g., Lanovaz & Sladeczek, 2011; Saylor et al., 2012). The main advantage of noncontingent music is that it is arguably the simplest intervention to implement for vocal stereotypy. The practitioner only needs to turn on preferred music, which allows her to attend to other tasks during this time. Moreover, the intervention may not be disruptive to others when headphones are used to provide the music. Whether noncontingent music will interfere with a person's own appropriate behavior remains unclear in the research literature. Burleson, Center, and Reeves (1989) found that background music increased task accuracy in children with autism. In another study, Lanovaz, Sladeczek, and Rapp (2012) reported mixed results on the functional play of four children: music increased functional play in one participant, reduced functional play in another, and produced no effect on the same behavior of the remaining participants.

A second concern is that playing noncontingent music may increase engagement in untargeted forms of motor stereotypy (Rapp, 2005; Rapp et al., 2013). From a clinical standpoint, reducing one form of stereotypy with an intervention that increases a second form would be counterproductive. An effective intervention should reduce, or at least not increase, untargeted motor forms of stereotypy. Finally, researchers have generally assessed the effects of noncontingent music during 5- to 10-min brief sessions (e.g., Rapp et al., 2013; Saylor et al., 2012). Results of a study conducted using items that were manipulated by participants indicated that the effects of noncontingent access may not continue during extended sessions because individuals may stop to engage with the items following repeated exposure (Lindberg, Iwata, Roscoe, Worsdell, & Hanley, 2003). That said, the effects of extended application of music may differ because the individual does not need to engage in a response to access the auditory stimulation; the music plays throughout the entire session regardless of the individual's behavior.

Another potential treatment is DRA, which is one of the behavioral interventions with the most empirical support to reduce engagement in stereotypy (DiGennaro Reed, Hirst, & Hyman, 2012; Rapp & Vollmer, 2005). The main advantage of DRA is that the intervention may simultaneously strengthen an appropriate behavior, minimizing the probability that it will be replaced by another form of stereotypy (Lanovaz, Robertson, Soerono, & Watkins, 2013). However, most prior studies have examined the effects of DRA on *motor* stereotypy. Given that engagement in vocal stereotypy is not necessarily incompatible with many alternative behavior (e.g., playing, completing a task), the effects of DRA may differ from those observed with motor forms of the behavior. In a recent exception, Lanovaz, Rapp, and Ferguson (2013) found that reinforcing an appropriate behavior associated with low levels of vocal stereotypy (i.e., sitting) produced reductions in vocal stereotypy for one participant. In applied settings, the alternative behavior targeted for increase may not necessarily be associated with low levels of stereotypy. As such, it remains unclear whether strengthening an appropriate behavior, independent of its association with low levels of vocal stereotypy, would also produce desirable outcomes.

Based on the previous limitations, the main purpose of the study was to investigate the direct and collateral outcomes of multiple interventions in individuals with autism and other developmental disabilities in order to guide the development of a sequential intervention model for vocal stereotypy. We first examined the effects of noncontingent music and DRA on engagement in vocal stereotypy, motor stereotypy, and appropriate alternative behavior. The study also aimed to identify potential modifications when the interventions did not reduce engagement in vocal stereotypy, or produced one or more undesirable collateral effects. Lastly, we examined potential limitations in order to assist practitioners in making informed decisions when selecting an intervention to reduce engagement in vocal stereotypy.

2. General method

2.1. Participants, data collection, response definitions, and interobserver agreement

Twelve individuals with autism and other developmental disabilities participated in one or two experiments. Four of the participants (i.e., David, Eric, Fred and Greg) had been involved in other experiments on the assessment and treatment of stereotypy conducted by the first two authors (see Lanovaz, Rapp, & Ferguson, 2012; Rapp et al., 2013). Each participant

Table 1
Characteristics of the participants.

Participant	Age	Diagnosis	Response Forms	IOA scores
Nicholas	12	Autism	Vocal stereotypy	*M* = 87% (range: 83–94%)
			Pacing	*M* = 93% (range: 82–99%)
			On-task behavior	*M* = 91% (range: 83–97%)
Zoe	36	Profound ID	Vocal Stereotypy	*M* = 91% (range: 80–98%)
		Down Syndrome	Rocking	*M* = 93% (range: 86–100%)
			Finger wiggling	*M* = 87% (range: 78–95%)
			Face touching	*M* = 90% (range: 85–93%)
			Object manipulation	*M* = 93% (range: 83–100%)
Kyle	4	Autism	Vocal stereotypy	*M* = 90% (range: 83–95%)
			On-task behavior	*M* = 91% (range: 83–100%)
Morgan	6	GDD	Vocal stereotypy	*M* = 93% (range: 88–99%)
		Language disorder	On-task behavior	*M* = 90% (range: 84–96%)
Lucas	37	Autism	Vocal stereotypy	*M* = 90% (range: 80–100%)
			Magazine viewing	*M* = 93% (range: 88–97%)
Ryan	7	Autism	Vocal stereotypy	*M* = 88% (range: 71–93%)
			Functional play	*M* = 97% (range: 94–100%)
Yasmine	63	Profound ID	Vocal stereotypy	*M* = 74% (range: 65–79%)
			On-task behavior	*M* = 96% (range: 87–100%)
David	6	Autism	Vocal stereotypy	*M* = 96% (range: 93–98%)
			Functional play	*M* = 93% (range: 83–100%)
Jacob	5	Autism	Vocal stereotypy	*M* = 86% (range: 82–91%)
			Mouthing	*M* = 95% (range: 93–100%)
			Object tapping	*M* = 93% (range: 87–98%)
			Task completion	N/A
Eric	4	Autism	Vocal stereotypy	*M* = 95% (range: 91–100%)
			Mouthing	*M* = 98% (range: 97–100%)
			Functional play	*M* = 76% (range: 66–83%)
Fred	9	Autism	Vocal stereotypy	*M* = 93% (range: 87–98%)
			Object tapping	*M* = 89% (range: 85–92%)
			Functional play	*M* = 86% (range: 81–91%)
Greg	6	Autism	Vocal stereotypy	*M* = 90% (range: 86–94%)
			Functional play	*M* = 90% (range: 82–94%)

Notes: GDD, global developmental delay; ID, intellectual disability; IOA, interobserver agreement.

engaged in vocal stereotypy and five participants also engaged in one or more forms of motor stereotypy. Based on the environment in which the interventions were to be implemented, we also targeted one appropriate behavior for each participant during the study. Table 1 presents each participant's age, diagnosis, and response forms. We only report motor forms of stereotypy when the mean percentage of engagement was at least 10% during baseline sessions.

Trained research assistants videotaped each session and subsequently scored the duration of each form of stereotypy and appropriate behavior. Table 2 presents the definition used to measure each response form. We used a 2-s offset criterion to measure vocal stereotypy for each participant. For Jacob, we measured the product of his appropriate behavior (i.e., task completion) rather than the duration by counting the number of items that he had transferred from one container to another at the end of the session. A second research assistant measured interobserver agreement (IOA) for approximately 35% of sessions for each participant using the block-by-block method with 10-s intervals. The mean IOA scores and ranges for each participant are presented in Table 1.

Table 2
Response definitions.

Response form	Definition
Vocal stereotypy	Acontextual sounds or words produced by the vocal apparatus
Pacing	Walking in a circular motion
Body rocking	Two or more forward and backward torso movements
Finger moving	Back and forth motion of fingers with or without holding an object
Face touching	Contact between the fingers and face or neck
Mouthing	Insertion of a body part or non-edible object past the place of the mouth
Object tapping	Two or more movements of the finger or hand making contact with a surface
On-task behavior	Using task materials in a manner consistent with their intended function
Object manipulation	Holding an object in one or both hands
Magazine viewing	Looking at a page of a magazine for at least 3 s without turning the page or looking elsewhere
Functional play	Using play materials in a manner consistent with their intended function

2.2. Preliminary assessments

2.2.1. Series of no-interaction conditions

Prior to the start of the current study, we conducted a series of 8–21 no-interaction conditions to examine whether each participant's repetitive vocalizations persisted in the absence of social consequences. During each 5-min condition, the participants had the opportunity to engage in the target appropriate behavior that would be measured in the subsequent experiments (e.g., playing, completing a task), but we provided no social consequences. Persistence of the repetitive vocalizations across the conditions indicated that the behavior was at least partly automatically reinforced (Querim et al., 2013). We excluded participants whose repetitive vocalizations did not persist across the series of no-interaction conditions or that did not occur for at least 15% of the time. As such, the vocal stereotypy of all participants in the current study persisted during the series of no-interaction conditions. The detailed results of the assessment are published elsewhere for some participants (Lanovaz, Rapp, et al., 2012) and available from the first author for the others.

2.2.2. Stimulus preference assessment

Depending on the type of stimuli involved in their interventions, each individual participated in preference assessments for edibles, music, or both. The research assistant selected five to eight stimuli presented during each preference assessment in collaboration with the individual's caregiver. To assess preference for edible items, we used the paired-choice stimulus preference assessment (Fisher et al., 1992). For music, we conducted a modified paired-choice preference assessment (Horrocks & Higbee, 2008; Lanovaz, Rapp, et al., 2013). The stimulus selected the most often during each assessment was used as the reinforcer or preferred stimulus during the interventions. For Jacob, the experimenter selected the musical stimulus in collaboration with the caregiver because his results indicated that he selected songs regardless of musical preference (i.e., based on the side of presentation).

3. Experiment 1: direct and collateral effects of noncontingent music and differential reinforcement of alternative behavior

3.1. Participants, materials, and settings

Nicholas, Zoe, Kyle, Morgan, Lucas, Ryan, and Yasmine participated in the first experiment. We conducted the sessions in settings in which the participants typically engaged in their appropriate target behavior. During their sessions, Nicholas, Kyle, and Morgan, had access to materials to complete fine motor activities (e.g., puzzles, beads and threads, pushpins, tracing) whereas Yasmine had clothes to fold. We selected these tasks because the participants could perform them independently and complete them within the duration of the session. The other participants engaged in object manipulation or functional play: Zoe had continuous access to items that provided sensory stimulation, Lucas to magazines, and Ryan to age-appropriate toys.

3.2. Procedures

To compare the effects of the two interventions, we alternated baseline, noncontingent music, and DRA conditions within a multielement design. With the exception of Yasmine whose sessions were 15 min in duration, we measured each response form for 10 min during and for 10 min after the intervention. For individuals engaging in tasks, the session was terminated if the individual finished his or her series of tasks before the end of the 10-min session. The post-intervention sessions were the same as baseline (see below), regardless of the preceding intervention. We did not measure post-intervention effects for Yasmine because her task already lasted 15 min and she had limited availabilities.

At the start of each baseline session, the participants were prompted to engage in their appropriate behavior (e.g., the research assistant said, "do your task" or "you can play now"). No further consequences were provided during the entire duration of the session. The noncontingent music condition was similar to baseline with the exception that the participant's most preferred song played continuously for the duration of the session through external speakers in the background. During the DRA condition, we provided a reinforcer on a variable-interval (VI) schedule contingent on engagement in the target appropriate behavior. Initially, the duration of the interval was 8 s for Morgan. For Lucas, we had initially started with 15 s and changed to 8 s, which allowed us to examine whether the denser schedule produced more desirable outcomes. Our preliminary data indicated that the dense schedules may have interrupted engagement in appropriate behavior and be unpractical to implement in applied setting; as a result, we only used 15-s intervals for the other participants. We provided edible items as reinforcers for all participants except Nicholas because he did not select a single edible item during the preference assessment. Instead, we used music as a reinforcer, which we provided on a 15-s VI schedule. When Nicholas met the reinforcement schedule requirement, we turned on the music until the end of the ongoing interval.

3.3. Results and discussion

For each experiment, we present the immediate effects of the interventions for each participant in a graphical format. However, the graphs depicting the subsequent effects were presented only when the intervention produced both immediate

Table 3
Means and ranges for each participant across conditions for Experiment 1.

Participants	Intervention			Post-intervention		
	Baseline	Music	DRA	Baseline	Music	DRA
Nicholas						
Vocal stereotypy	51% (17–87%)	21% ↓ (1–45%)	44% (15–75%)	45% (31–66%)	35% (3–72%)	40% (9–63%)
Pacing	19% (2–30%)	7% ↓ (0–14%)	11% (0–27%)	7% (0–20%)	9% (0–16%)	6% (0–21%)
On-task behavior	12% (2–58%)	35% ↑ (3–82%)	9% (0–32%)	21% (4–32%)	30% (0–81%)	29% (0–77%)
Zoe						
Vocal stereotypy	87% (64–98%)	80% (52–97%)	57% ↓ (10–91%)	90% (78–99%)	91% (79–99%)	75% (24–99%)
Rocking	65% (0–95%)	73% (1–98%)	18% ↓ (0–66%)	73% (0–99%)	82% (5–100%)	38% (0–90%)
Finger wiggling	60% (6–93%)	47% (4–89%)	14% ↓ (1–46%)	59% (10–94%)	65% (5–94%)	35% (1–86%)
Face touching	15% (4–69%)	17% (3–60%)	31% (7–75%)	26% (4–82%)	16% (3–75%)	35% (5–81%)
Object manipulation	3% (1–9%)	4% (0–19%)	9% ↑ (3–23%)	1% (0–4%)	1% (0–7%)	2% (0–5%)
Kyle						
Vocal stereotypy	36% (10–53%)	0% ↓ (0–2%)	26% (15–38%)	38% (15–57%)	18% ↓ (4–35%)	37% (21–49%)
On-task behavior	26% (0–57%)	41% ↑ (17–59%)	19% (1–45%)	22% (0–59%)	30% (0–58%)	15% (1–37%)
Morgan						
Vocal stereotypy	86% (79–99%)	26% ↓ (4–58%)	14% ↓ (7–23%)	88% (76–97%)	83% (35–96%)	87% (57–98%)
On-task behavior	42% (21–72%)	35% (15–66%)	28% (20–34%)	31% (17–51%)	26% (3–44%)	28% (5–61%)
Lucas						
Vocal stereotypy	31% (1–60%)	8% ↓ (0–38%)	22% (5–38%)	35% (3–68%)	28% (6–56%)	31% (9–54%)
Magazine viewing	9% (3–16%)	6% (0–15%)	5% ↓ (1–16%)	10% (0–23%)	12% (4–20%)	10% (1–19%)
Ryan						
Vocal stereotypy	13% (1–29%)	20% (5–44%)	27% (8–60%)	19% (8–33%)	28% (2–52%)	11% (2–36%)
Functional play	15% (0–34%)	21% (0–40%)	7% (0–32%)	4% (0–10%)	6% (0–14%)	3% (0–10%)
Yasmine						
Vocal stereotypy	35% (28–44%)	28% (22–34%)	43% (30–65%)	–	–	–
On-task behavior	95% (76–100%)	96% (94–100%)	84% (87–99%)			

Notes: DRA: differential reinforcement of alternative behavior, ↑: increase compared to baseline (based on visual inspection of multielement graph), ↓: reduction compared to baseline.

and subsequent changes in at least one response form. Otherwise, we report the means and ranges in tables. Note that the subsequent graphs that were not included in the current paper are available from the first author. Table 3 presents the means and ranges for each participant's response forms. Fig. 1 shows the percentage of time Nicholas (three upper panels) and Zoe (five lower panels) engaged in stereotypy and appropriate behavior during the interventions. For Nicholas, noncontingent music reduced vocal stereotypy and pacing while increasing on-task behavior whereas DRA did not produce consistent effects when compared to baseline. In contrast, DRA reduced vocal stereotypy (though not to clinically significant levels), body rocking and finger moving, and marginally increased object manipulation for Zoe. Noncontingent music did not produce clear changes in her response forms. For both participants, post-intervention levels of each response form remained similar across conditions (data not depicted).

Fig. 2 shows the results of the analyses for Kyle (four upper panels), Morgan (two lower middle panels), and Lucas (two lower panels). For Kyle, noncontingent music reduced immediate engagement in vocal stereotypy and maintained higher levels of on-task behavior than the other conditions. The intervention also reduced subsequent engagement in vocal stereotypy, but the effects appeared to fade over time. In contrast, DRA did not produce systematic changes in either vocal stereotypy or on-task behavior. For Morgan, both interventions decreased engagement in vocal stereotypy compared to

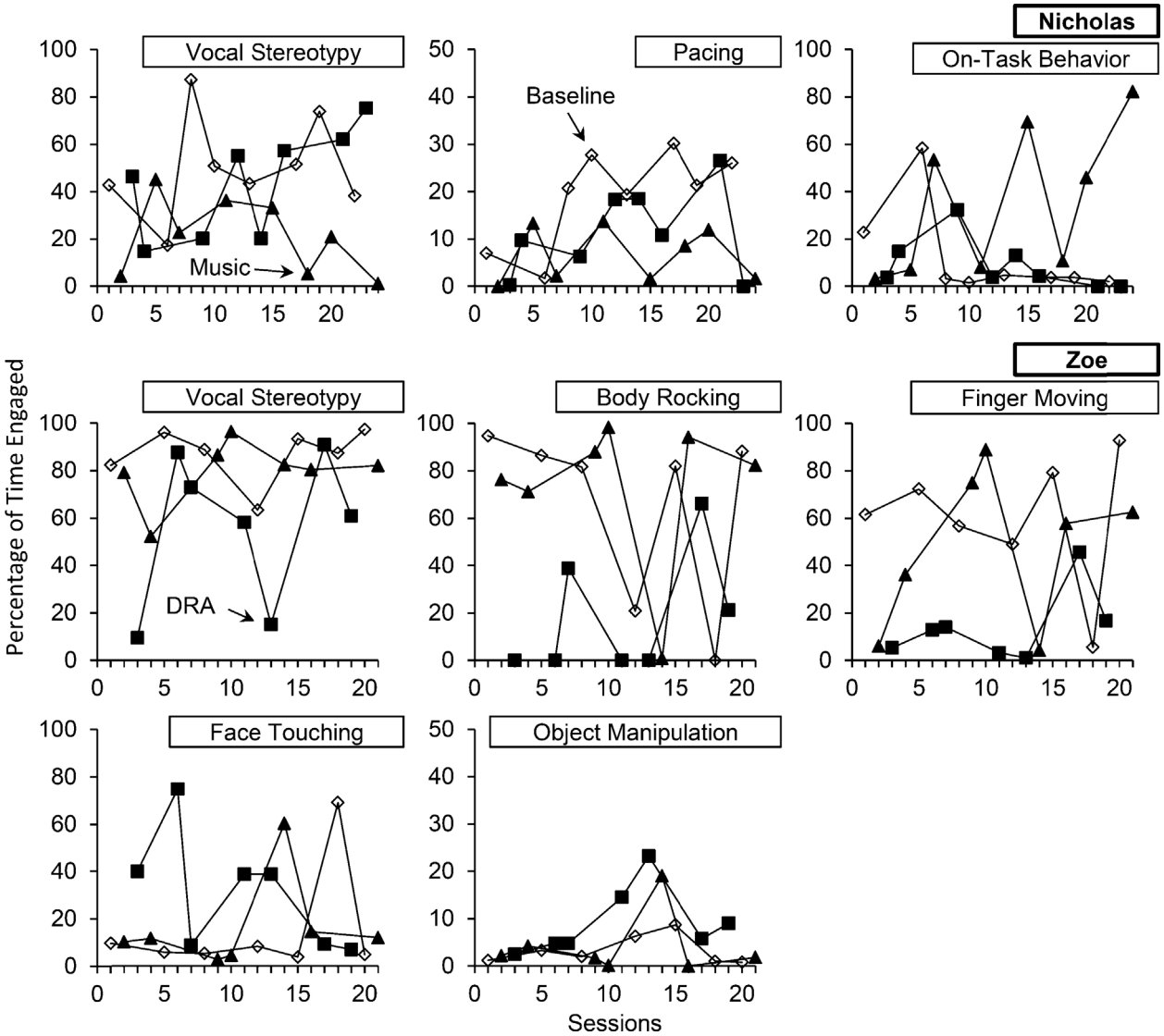

Fig. 1. Percentage of time Nicholas (three upper panels) and Zoe (five lower panels) engaged in vocal stereotypy, motor stereotypy, and appropriate behavior during baseline, noncontingent music, and differential reinforcement of alternative behavior (DRA) sessions.

baseline, but DRA produced a larger mean reduction. The interventions did not increase engagement in on-task behavior. Post-intervention levels also remained similar across conditions (data not depicted). Noncontingent music reduced Lucas' vocal stereotypy and did not interfere with magazine viewing. Contrarily, DRA did not systematically alter engagement in his vocal stereotypy, but decreased engagement in magazine viewing. We did not observe any consistent changes in post-intervention levels for both response forms (data not depicted). Fig. 3 shows that the two interventions failed to produce systematic changes in stereotypy and appropriate behavior for Ryan and Yasmine.

At least one of the two interventions reduced immediate engagement in vocal stereotypy for 5 of 7 participants. Noncontingent music reduced immediate engagement in vocal stereotypy in four participants, increased appropriate behavior in two of them, and also reduced collateral motor forms of stereotypy in one participant. On the other hand, DRA reduced immediate engagement in vocal stereotypy in two participants, motor stereotypy in one participant, and appropriate behavior in one participant. For two of the participants, both interventions failed to produce desirable outcomes, underlining the importance of examining other alternatives.

4. Experiment 2: direct and collateral effects of differential reinforcement of other behavior

Researchers have shown that DRO may be an effective intervention to reduce engagement in vocal stereotypy (e.g., Rozenblat et al., 2009; Taylor et al., 2005). When the first intervention fails to reduce engagement in vocal stereotypy, DRO may thus be a suitable alternative in a sequential intervention model. Similarly to other interventions, the use of DRO is

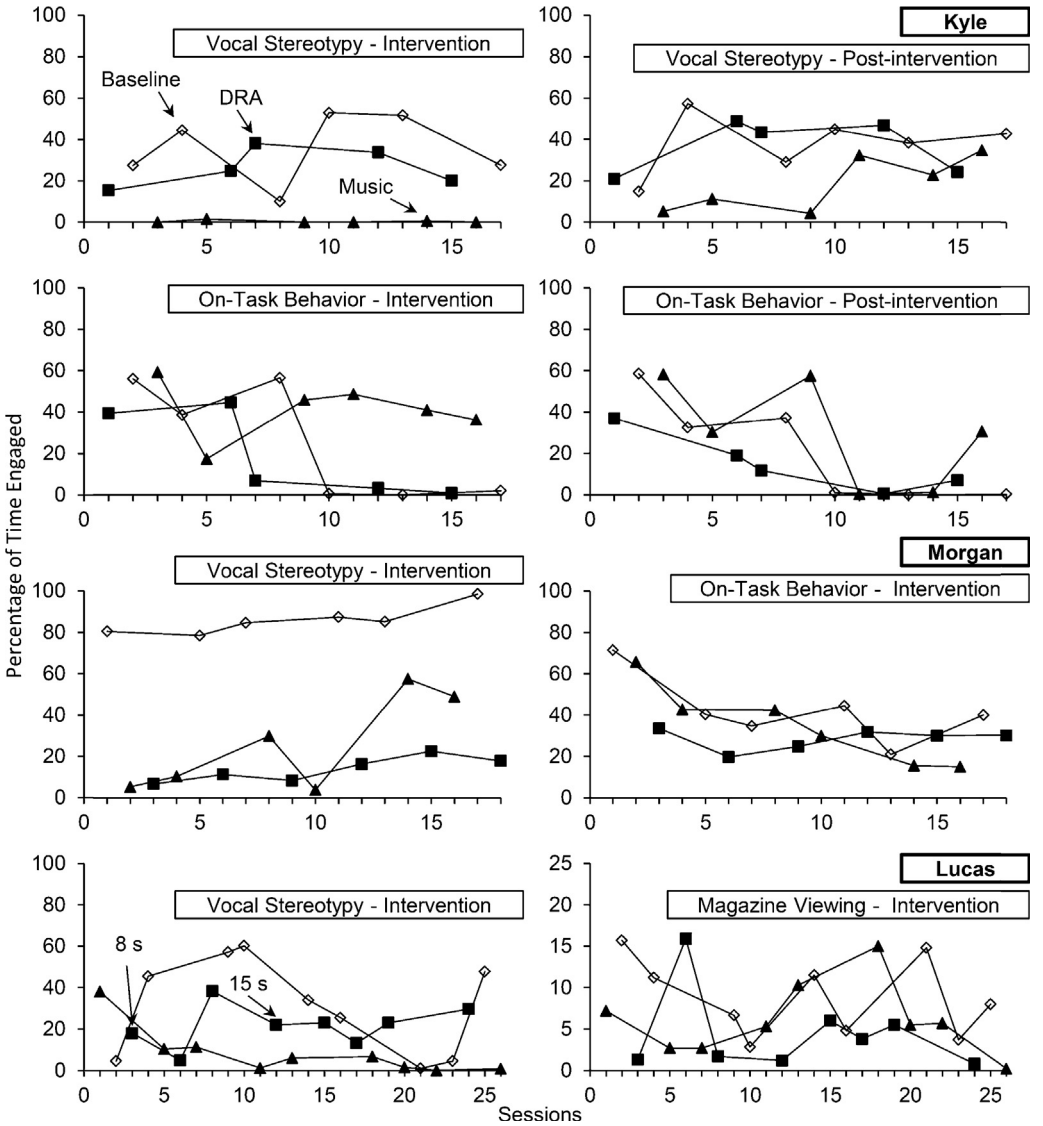

Fig. 2. Percentage of time Kyle (four upper panels), Morgan (two lower middle panels), and Lucas (two lower panels) engaged in vocal stereotypy and appropriate behavior during and following baseline, noncontingent music, and differential reinforcement of alternative behavior (DRA) sessions.

limited insofar as its effects on appropriate behavior have not been thoroughly documented by researchers. The purpose of the second experiment was to examine the direct and collateral effects of implementing DRO to reduce engagement in vocal stereotypy.

4.1. Participants and settings

Ryan and Yasmine participated in this experiment because both noncontingent music and DRA had failed to reduce their engagement in stereotypy during the first experiment. We also included David for whom noncontingent music did not reduce vocal stereotypy in a previous study (Lanovaz, Rapp, et al., 2012). For Ryan and Yasmine, the settings and materials were the same as Experiment 1. David had noncontingent access to age-appropriate toys.

4.2. Procedures

The experimental design and data analyses were the same as in Experiment 1 with the following exceptions. We used an AB design for Yasmine to reduce the number of sessions conducted with her due to her limited availabilities. Given that her results showed that the intervention clearly increased engagement in vocal stereotypy, we did not conduct a return to baseline. The baseline conditions were the same as in Experiment 1. During DRO, the participant received access to the

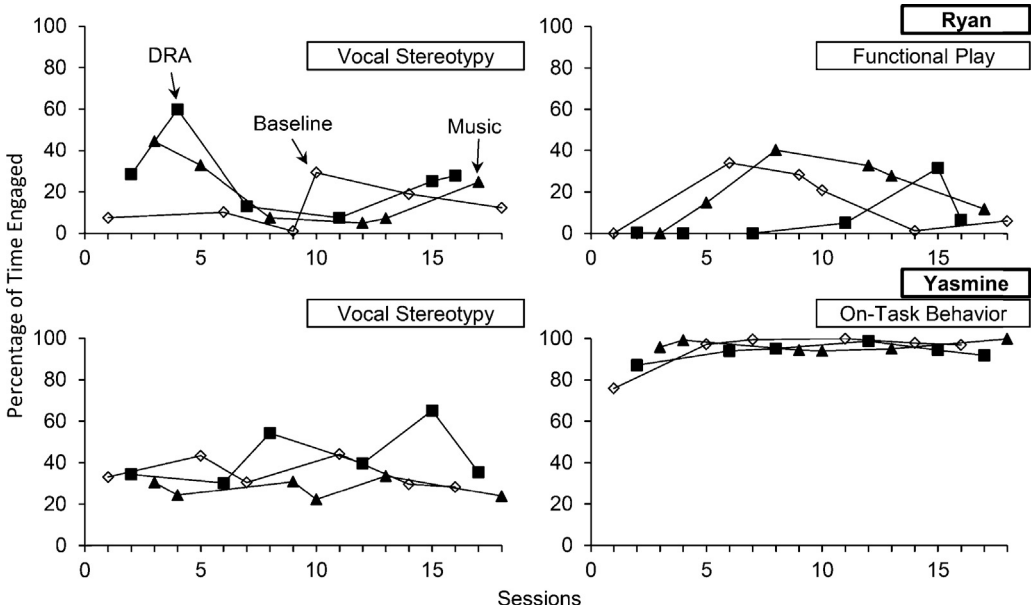

Fig. 3. Percentage of time Ryan (two upper panels) and Yasmine (two lower panels) engaged in vocal stereotypy and appropriate behavior during baseline, noncontingent music, and differential reinforcement of alternative behavior (DRA) sessions.

reinforcer when he or she had not engaged in vocal stereotypy during the entire interval. If the participant engaged in vocal stereotypy at any point in time, the interval was reset. Ryan and Yasmine received edible reinforcers whereas David received access to the music for a period equivalent to the duration of the interval. For David, we started with a fixed-duration 8-s interval, but thinned it up to 30 s. We used a fixed-duration 10-s interval for Ryan and Yasmine.

4.3. Results and discussion

Table 4 presents the means and ranges of the response forms for the three participants. Fig. 4 displays the multielement graphs for each participant. For David, DRO reduced both immediate and subsequent engagement in vocal stereotypy, but immediate and subsequent levels of functional play remained consistently low. For Ryan, DRO also reduced immediate engagement in vocal stereotypy, but produced marginal post-intervention increases in the response form. We did not observe systematic changes in functional play. For Yasmine, DRO neither reduced vocal stereotypy nor increased appropriate behavior, which was already near 100% during baseline. Our results suggest that DRO may reduce vocal stereotypy when other interventions have failed to do so, but that the intervention does not necessarily evoke, or produce reallocation toward, appropriate behavior.

Table 4
Means and ranges for each participant across conditions for Experiment 2.

	Intervention		Post-intervention	
Participants	Baseline	DRO	Baseline	DRO
David				
Vocal stereotypy	39% (1–60%)	6% ↓ (0–38%)	47% (23–61%)	32% ↓ (12–45%)
Functional play	7% (0–23%)	11% (0–76%)	8% (0–46%)	12% (0–96%)
Ryan				
Vocal stereotypy	35% (11–68%)	18% ↓ (4–46%)	19% (10–49%)	31% ↑ (19–85%)
Functional play	14% (0–41%)	5% (0–15%)	18% (0–67%)	15% (0–45%)
Yasmine				
Vocal stereotypy	35% (28–44%)	57% ↑ (42–74%)	–	–
On-task behavior	95% (76–100%)	98% (95–100%)		

Notes: DRO: differential reinforcement of other behavior, ↑: increase compared to baseline (based on visual inspection of graph), ↓: reduction compared to baseline.

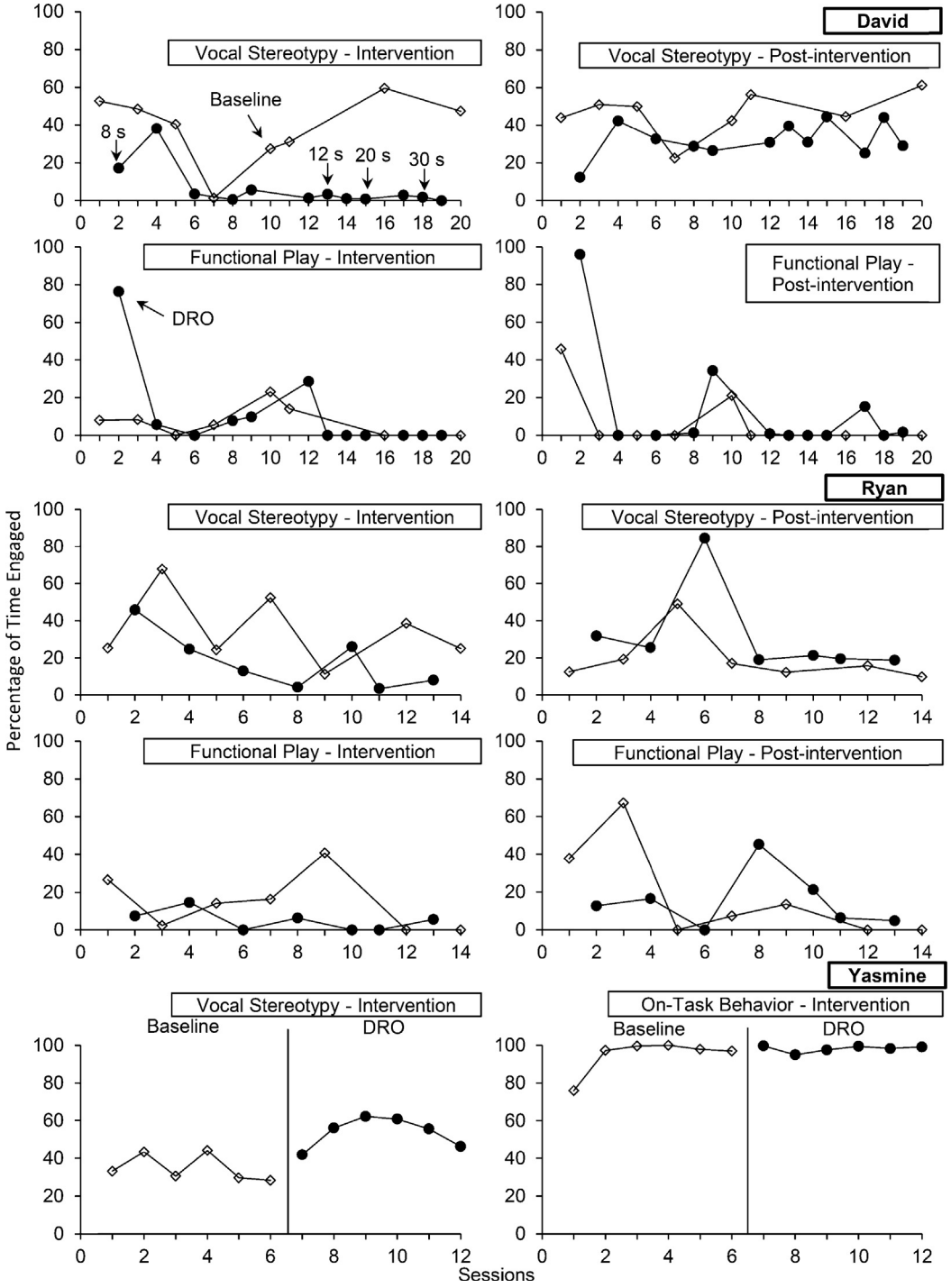

Fig. 4. Percentage of time David (four upper panels), Ryan (four middle panels), and Yasmine (two lower panels) engaged in vocal stereotypy and appropriate behavior during and following baseline and differential reinforcement of other behavior (DRO) sessions.

5. Experiment 3: adding prompts to increase appropriate behavior

Prior research and our previous experiments suggest that interventions that reduce stereotypy may fail to produce desirable effects on collateral behavior. For example, Rapp et al. (2013) have found that while providing noncontingent access to auditory stimulation may reduce engagement in vocal stereotypy, the intervention may also increase untargeted motor forms of stereotypy for some individuals. In our current study, we also observed that reducing vocal and motor

stereotypy does not necessarily produce response reallocation toward appropriate alternative behavior (e.g., Zoe, Morgan). To this end, one of the simplest interventions to increase alternative behavior is to provide prompting when the person is not engaging in the appropriate behavior (e.g., Britton, Carr, Landaburu, & Romick, 2002; Singh & Millichamp, 1987). Moreover, some researchers have found that prompting alone may reduce engagement in motor forms of stereotypy (Symons & Davis, 1994). The purpose of the third experiment was to examine the direct and collateral effects of interventions with prompts.

5.1. Participants and settings

Zoe, Morgan, Jacob, Eric, Fred, and Greg participated in the third experiment. Zoe and Morgan were included because both participants were still available following Experiment 1 and levels of appropriate behavior remained low despite reductions in stereotypy. The setting of their intervention remained the same. We invited Jacob to participate in the study because we had been informed by his educator that he was unable to engage in independent tasks unless he was prompted. Jacob completed a simple task of transferring items from one container to another during the sessions. Finally, our results from previous studies suggested that noncontingent music alone failed to increase functional play, increased motor stereotypy, or both for Eric, Fred, and Greg (Lanovaz, Rapp, et al., 2012; Rapp et al., 2013). These three participants had access to age-appropriate toys during their sessions. The participants were familiar with the toys, had the necessary skills to interact with them, but rarely did so independently.

5.2. Procedures

The design, procedures, and interventions remained the same as in Experiments 1 and 2 with the inclusion of a few minor changes. Because Jacob was only available once per week and we had to conduct many sessions in the same day, his sessions lasted only 5 min and we did not measure post-intervention effects. His DRA consisted of a continuous reinforcement schedule (i.e., fixed ratio 1) each time he transferred an item from one container to another. We also made some changes to the DRA intervention for Greg. He only received his reinforcer if he was engaging in functional play when the interval ended (and not for the first occurrence following the end of the interval as in a typical interval schedule) and its duration was fixed. This change was to facilitate the subsequent implementation by his parent. For Zoe, we only assessed DRA with prompting as DRA was the intervention that had produced the most desirable outcomes on stereotypy in Experiment 1. Similarly for Eric and Fred, we focused exclusively on noncontingent music with prompting as previous studies had shown that the intervention failed to produce desirable collateral effects for these participants (Lanovaz, Rapp, et al., 2012; Rapp et al., 2013). Finally, we combined noncontingent music with DRA for Greg in order to examine the unique contribution of the latter.

For all participants, we added a prompting procedure across all conditions (i.e., baseline, noncontingent music, and DRA). For Jacob, Eric, Fred, and Greg, the prompting procedure involved providing a physical prompt every 15 s if the child was not engaging in the appropriate behavior. For Morgan, we implemented a least-to-most prompting procedure to engage in on-task behavior contingent on the occurrence of targeted disruptive behavior (i.e., playing with materials, standing up, and rocking the chair) because our observations suggested that these behaviors interfered with task engagement. During the least-to-most prompting sequence, the research assistant began with a verbal prompt. If the participant did not comply with the verbal prompt within 5 s, the research assistant added a gestural prompt. If Morgan still did not comply with the verbal plus gestural prompt, the research assistant subsequently added a physical prompt. Finally, the research assistants noted that Zoe engaged in higher levels of engagement when her educator placed an item in her hands. Thus, the prompting procedure involved giving her an item that provided sensory stimulation as soon as she had not manipulated an item for 2 s.

5.3. Results and discussion

Table 5 displays the means and ranges for each participant across conditions. Fig. 5 shows the immediate (upper five panels) and subsequent effects (lower five panels) of DRA for Zoe. Results suggest that combining DRA with prompting continued to produce immediate reductions in vocal stereotypy, body rocking, and finger moving, but also marginally increased face touching. Levels of object manipulation remained similar across the prompting and DRA with prompting conditions, but were considerably higher than levels observed in Experiment 1. Moreover, DRA with prompting respectively decreased and increased subsequent engagement in finger moving and face touching. Fig. 6 shows the immediate and subsequent results of implementing prompting with noncontingent music and DRA for Morgan (upper four panels) and Jacob (lower four panels). Compared with prompting alone, DRA with prompting reduced immediate and subsequent engagement in vocal stereotypy for Morgan, but also reduced immediate engagement in on-task behavior. The only consistent effect of noncontingent music with prompting was to reduce immediate engagement in vocal stereotypy, albeit to a lesser extent than DRA. For Jacob, combining DRA with prompting reduced engagement in vocal stereotypy and mouthing as well as the rate of task completion. Noncontingent music also reduced vocal stereotypy, but mean levels remained higher than for DRA.

Fig. 7 shows the percentage of time Eric, Fred, and Greg engaged in stereotypy and appropriate behavior during the interventions that involved prompting. For Eric, noncontingent music with prompting reduced vocal stereotypy, produced no consistent changes in mouthing, and increased functional play. For Fred, noncontingent music with prompting only produced reductions in vocal stereotypy. For Greg, DRA with prompting reduced engagement in vocal stereotypy, but the addition of noncontingent music produced even larger reductions. Nevertheless, these reductions did not appear to produce

Table 5
Means and ranges for each participant across conditions for Experiment 3.

	Intervention			Post-intervention		
Participants	Baseline	Music[a]	DRA	Baseline	Music[a]	DRA
Zoe						
Vocal stereotypy	97% (92–100%)		63% ↓ (28–93%)	98% (96–100%)		88% (62–98%)
Rocking	90% (77–98%)		34% ↓ (1–80%)	90% (84–96%)		71% (23–97%)
Finger wiggling	65% (51–81%)		20% ↓ (1–59%)	66% (39–80%)		43% ↓ (2–72%)
Face touching	7% (5–12%)		12% ↑ (7–25%)	7% (3–11%)		15% ↑ (5–39%)
Object manipulation	25% (17–35%)		25% (17–34%)	23% (12–35%)		29% (18–41%)
Morgan						
Vocal stereotypy	87% (69–98%)	28% ↓ (3–59%)	9% ↓ (1–26%)	92% (85–97%)	80% (48–95%)	80% ↓ (71–91%)
On-task behavior	69% (62–77%)	63% (58–72%)	37% ↓ (29–47%)	67% (59–84%)	68% (48–84%)	56% ↓ (21–66%)
Jacob						
Vocal stereotypy	45% (35–57%)	31%↓ (13–49%)	23% ↓ (5–46%)	–	–	–
Mouthing	35% (16–59%)	49% (27–73%)	0% ↓ (0–2%)			
Object tapping	15% (6–38%)	13% (5–28%)	10% (3–16%)			
Task rate (per min)	8 (5–12)	10 (5–18)	5 ↓ (4–8)			
Eric						
Vocal stereotypy	10% (0–17%)	1% ↓ (0–4%)	–	17% (4–40%)	8% (3–17%)	
Mouthing	13% (0–72%)	7% (0–28%)		20% (0–40%)	12% (0–50%)	–
Functional play	21% (9–38%)	39% ↑ (13–73%)		19% (6–29%)	22% (9–51%)	
Fred						
Vocal stereotypy	55% (9–84%)	21% ↓ (5–62%)		41% (22–54%)	51% (15–76%)	
Object tapping	15% (4–21%)	12% (11–17%)	–	11% (2–17%)	12% (6–25%)	–
Functional play	23% (16–36%)	28% (14–51%)		26% (16–40%)	32% (16–44%)	
Greg						
Vocal stereotypy	47% (28–65%)	5% ↓ (1–11%)	28% ↓ (14–46%)	47% (31–59%)	49% (40–65%)	42% (25–53%)
Functional play	33% (10–66%)	38% (30–52%)	49% (30–77%)	9% (0–26%)	13% (2–61%)	6% (1–11%)

Notes: DRA: differential reinforcement of alternative behavior, ↑: increase compared to baseline (based on visual inspection of multielement graph), ↓: reduction compared to baseline.
[a] Music combined with DRA for Greg.

reallocation toward functional play. We did not observe systematic post-intervention changes across conditions for any of the three participants (data not depicted). The results suggest that prompting did not interfere with the effectiveness of the interventions in reducing stereotypy. Furthermore, noncontingent music increased functional play in one participant and did not appear to interfere with engagement in appropriate behavior for the others.

6. Experiment 4: effects of extended exposure

Our previous experiments indicate that using noncontingent music alone or in combination with prompting may be a suitable first intervention for a sequential intervention model. In addition to reducing engagement in vocal stereotypy, the intervention never increased motor forms of stereotypy, nor interfered with engagement in appropriate behavior. Moreover, noncontingent music sometimes increased engagement in appropriate behavior. Given that we assessed the effects of music

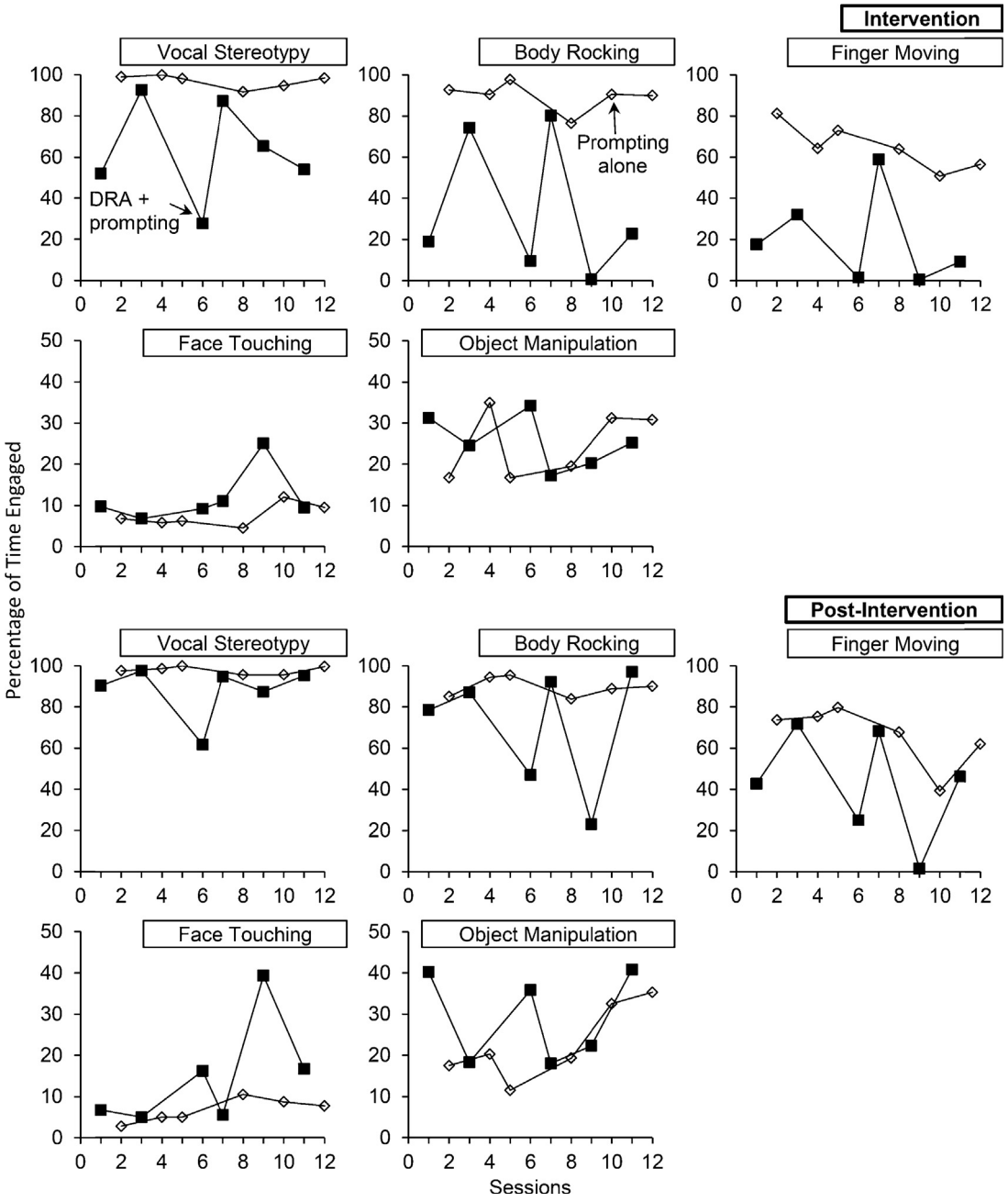

Fig. 5. Percentage of time Zoe engaged in vocal stereotypy, motor stereotypy, and object manipulation during (five upper panels) and following (five lower panels) prompting alone and differential reinforcement of alternative behavior (DRA) with prompting sessions.

only during brief 10-min sessions, we examined whether the positive outcome would persist for sessions of longer duration to extend the potential utility of the results of the current study.

6.1. Participants and procedures

We invited Eric and Fred to participate in the fourth experiment. Eric participated in three 90-min sessions and Fred in four 50- to 60-min sessions. Session durations were shorter for Fred because he engaged in elopement when he stayed in the same room for extended periods of time. Both participants had access to the same age-appropriate toys as during Experiment 3 and we provided no social consequences for engaging in vocal stereotypy or functional play. During these periods, the participants were free to play with the toys and move around the room. Eric initially participated in two 90-min sessions

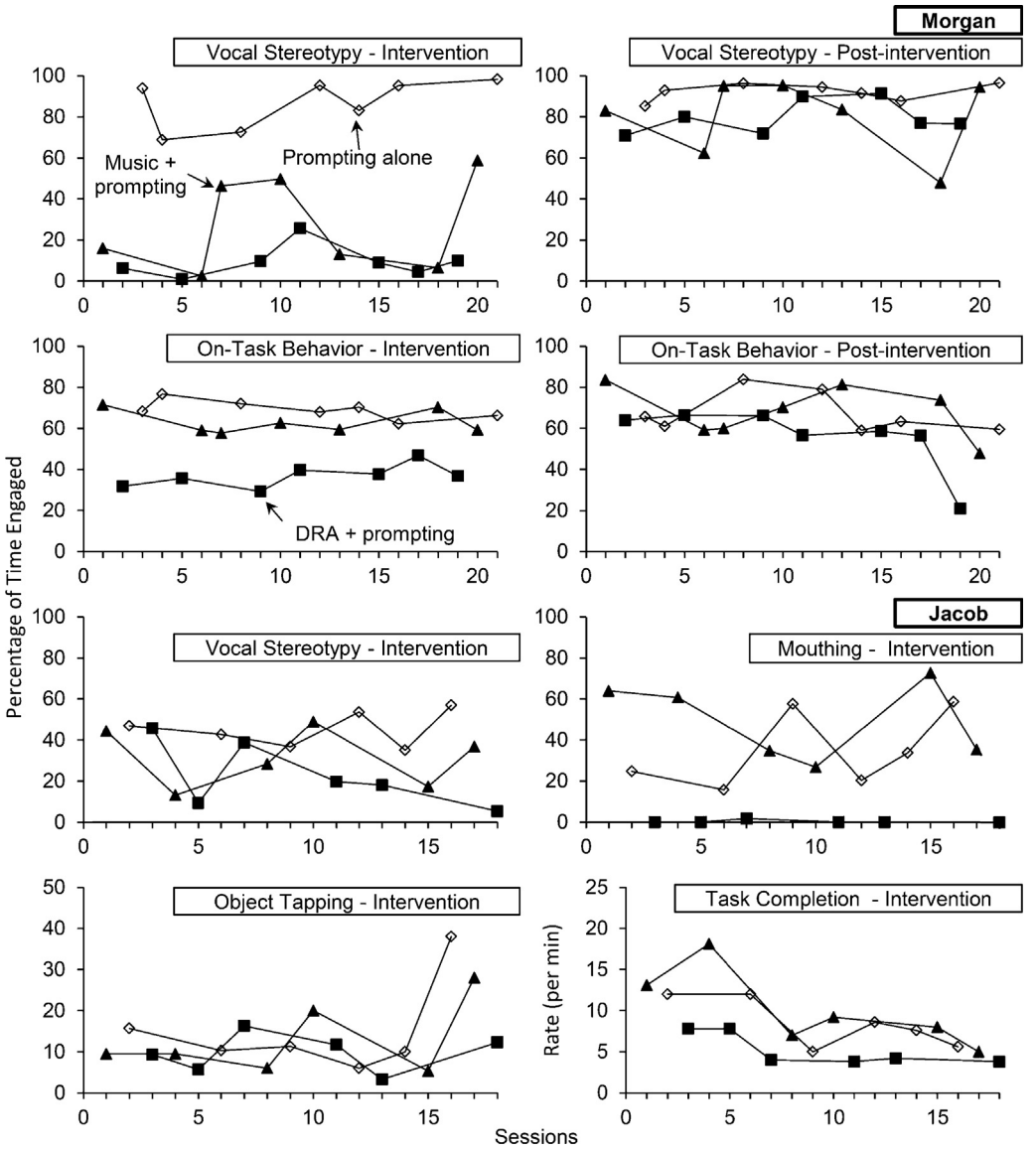

Fig. 6. Percentage of time and rate Morgan (four upper panels) and Jacob (four lower panels) engaged in vocal stereotypy, motor stereotypy, and appropriate behavior during and following prompting alone, noncontingent music with prompting, and differential reinforcement of alternative behavior (DRA) with prompting sessions.

during which his preferred song played continuously in a loop and then in one 90-min session during which the children's songs varied. Fred participated in a brief reversal: the first two sessions involved the same preferred song playing in a loop, the third session did not include music, and the last session returned to the same preferred song in a loop.

6.2. Results and discussion

Fig. 8 presents the percentage of time Eric and Fred engaged in vocal stereotypy during 50- to 90-min sessions. The data were divided in 10-min intervals to facilitate comparisons with the other experiments and also to examine trends over the extended sessions. Eric (upper panel) maintained low and stable levels of vocal stereotypy (M = 10%) during the first 90-min session with the same song playing in a loop (i.e., constant music), but levels increased following 30 min into the second 90-min session (M = 33%). When we introduced varied music, engagement in vocal stereotypy returned to low levels during the entire 90-min session (M = 7%). The first session for Fred (lower panel) only lasted 50 min because he made several attempts to leave the room. Levels of vocal stereotypy when his preferred song played continuously in a loop were generally low, but showed a slight increasing trend across the last 30 min of the session (M = 8%). During the second session, Fred also displayed generally low levels of vocal stereotypy (M = 12%). The withdrawal of music for an entire 60-min session produced increases

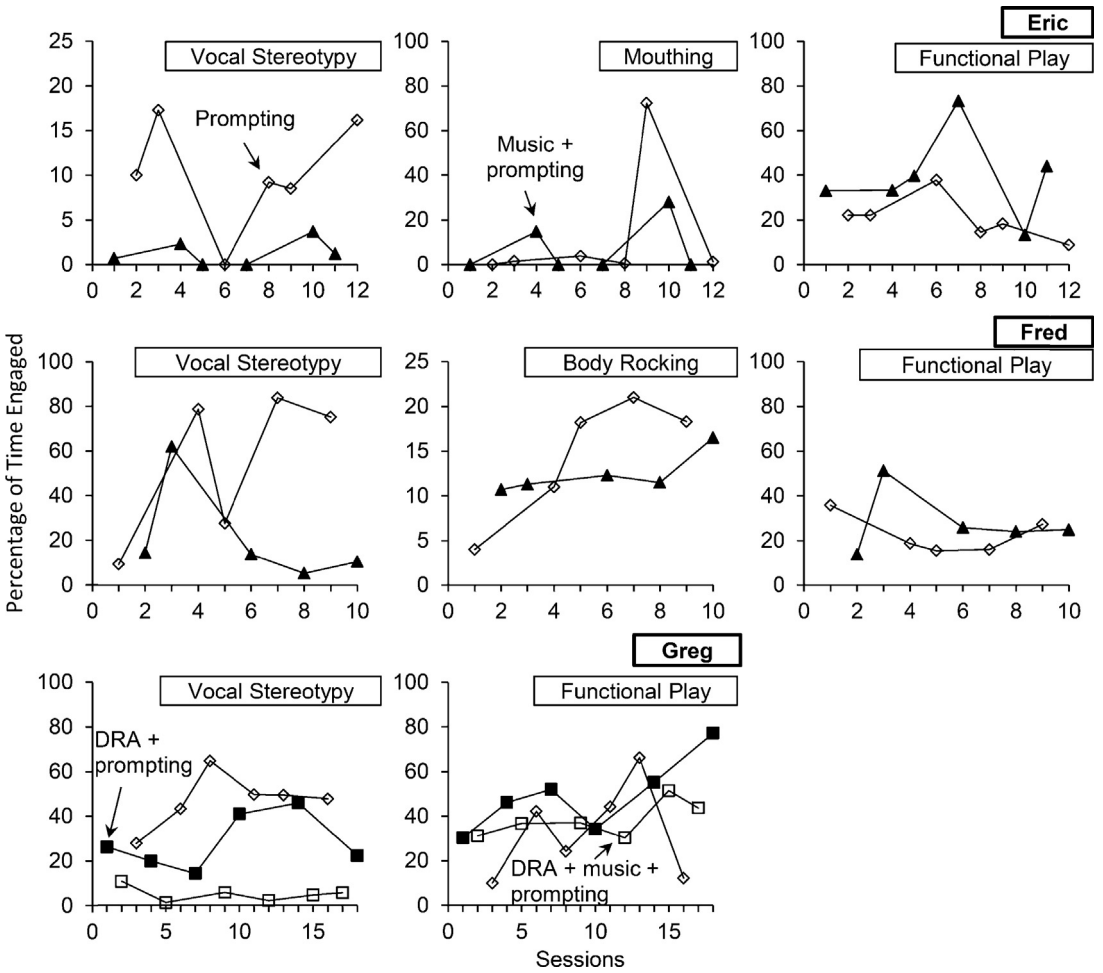

Fig. 7. Percentage of time Eric (three upper panels) and Fred (three middle panels) engaged in stereotypy and functional play during prompting alone and noncontingent music with prompting sessions. Percentage of time Greg (two lower panels) engaged in vocal stereotypy and functional play during prompting alone, differential reinforcement of alternative behavior (DRA) with prompting, and DRA plus noncontingent music with prompting sessions.

in engagement in vocal stereotypy ($M = 63\%$) when compared to the constant music sessions. The reintroduction of the preferred song for a final 60-min session clearly replicated the reductions in vocal stereotypy ($M = 8\%$) observed in the two initial sessions. The results suggest that the effects of music may continue across long session durations, but that it may be important to vary the song for some individuals.

7. General discussion

In sum, the first experiment indicated that noncontingent music generally produced better outcomes than DRA. The subsequent implementation of DRO in the second experiment reduced stereotypy in two of three participants for whom other interventions did not. In the third experiment, the addition of prompts did not interfere with the reductions in vocal stereotypy produced by the interventions while maintaining motor forms of stereotypy and appropriate behavior at desirable levels. Finally, the fourth experiment showed that the effects of noncontingent music may persist during sessions with extended durations.

Overall, at least one intervention reduced engagement in vocal stereotypy for 11 of 12 participants. Specifically, noncontingent music alone or with prompts reduced immediate engagement in vocal stereotypy in 8 of 11 participants with whom the intervention was implemented. When noncontingent music reduced immediate engagement in vocal stereotypy, we also observed immediate increases in appropriate behavior in three participants, immediate reductions in motor stereotypy in one participant, and subsequent decreases in vocal stereotypy in one participant. In contrast, DRA alone or in combination with prompts reduced vocal stereotypy in four of nine participants. Furthermore, the intervention was associated with reductions in motor stereotypy in two participants. The intervention also reduced appropriate behavior in two participants for whom the intervention had reduced immediate engagement in vocal stereotypy and marginally increased appropriate behavior in only one participant.

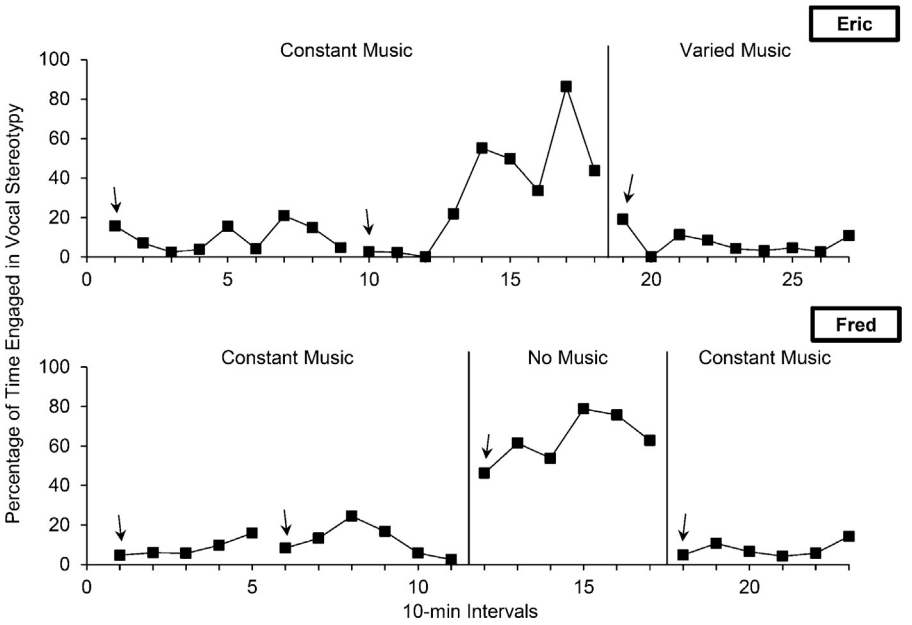

Fig. 8. Percentage of time Eric (upper panel) and Fred (lower panel) engaged in vocal stereotypy across 10-min intervals during 50- to 90-min sessions with no music, constant music, and varied music. The arrows identify the first 10-min interval for each extended session.

The main implication of the results is that noncontingent music may be more effective than DRA to reduce vocal stereotypy. Notably, noncontingent music reduced vocal stereotypy for 73% of participants whereas DRA reduced the behavior for 45% of participants, suggesting that it may be preferable to begin the sequential intervention model using noncontingent music. The collateral effects of noncontingent music were also clinically desirable: the intervention increased appropriate behavior in three participants, never interfered with appropriate behavior in the remaining participants, and never increased immediate or subsequent motor stereotypy. Noncontingent music also reduced vocal stereotypy for sessions with extended durations, but it was necessary to vary the song for one participant. Our results also suggest that practitioners should consider supplementing noncontingent music with prompts, which may hinder engagement with motor forms of stereotypy while strengthening or increasing engagement in appropriate behavior.

When noncontingent music fails to reduce stereotypy, DRO appears to be a more adequate alternative than DRA as it reduced stereotypy in a larger proportion of participants. That said, adding prompts may also be important for DRO as the intervention did not increase appropriate behavior if it was not already occurring at high levels during baseline sessions. For one participant (Yasmine), DRO increased engagement in vocal stereotypy. Her results suggest that another intervention should be planned as part of the sequential intervention model when both previous interventions do not produce the desired outcomes. The research literature suggests that response cost may be a suitable candidate to follow DRO (Falcomata et al., 2004; Watkins & Rapp, 2014), but studies should be conducted to confirm this hypothesis. Our analyses thus suggest that a potentially efficient sequential intervention model would involve the implementation of noncontingent music first, DRO second, and response cost last if both previous interventions failed to produce desirable effects.

Unexpectedly, DRA increased the target appropriate behavior for only one of nine participants. One potential explanation is that the schedules of reinforcement were not dense enough to increase the appropriate behavior. That said, we did not observe more desirable outcomes in the participants with denser schedules and any added benefits of using denser schedules would probably have been offset by the challenges associated with their implementation in applied settings. Another explanation is that the selection of the appropriate behavior may have contributed to how effective the DRA was at strengthening collateral behavior. That is, using different alternative behavior may have produced different results and should be investigated in the future. The reductions observed in appropriate behavior during DRA provide further support for research suggesting that dense schedules using edibles may disrupt engagement in other behavior (Frank-Crawford et al., 2012). Namely, the time spent consuming edibles may considerably reduce the amount of time available to engage in appropriate behavior, which would explain the results.

Altogether, the four experiments extend the research literature on the treatment of vocal stereotypy in several ways. First, our study is the first to systematically compare the effects of noncontingent music and DRA on vocal stereotypy, motor stereotypy, and appropriate behavior. Comparing treatments together is important as practitioners rely on these results when selecting behavioral interventions to implement in applied settings (Shabani & Lam, 2013). Second, our results extend previous research by showing that noncontingent music never interfered with ongoing appropriate behavior. On the contrary, noncontingent music was even associated with increases in appropriate behavior for some participants, a finding that is consistent with at least one prior study (Burleson et al., 1989). Hence, our results minimize a clinical concern that

noncontingent music may interfere with other important behavior (Lanovaz & Sladeczek, 2012). The observed changes in vocal stereotypy are also consistent with those of prior studies which showed that music reduced engagement in the behavior (e.g., Lanovaz & Sladeczek, 2011; Saylor et al., 2012).

Third, our results replicate the findings of other studies that have used DRO and have shown that the schedule may be thinned over time to make it easier to implement in applied settings (Rozenblat et al., 2009; Taylor et al., 2005). Fourth, the third experiment indicates that adding prompts does not interfere with the effectiveness of other behavioral interventions and may even enhance their effects. For example, we had shown in a previous study that noncontingent music increased motor stereotypy for Eric and Greg (Rapp et al., 2013). By contrast, such increases in motor stereotypy in the presence of prompts were not observed in this study. Finally, the fourth experiment replicated and extended the study with longer session durations conducted by Lindberg et al. (2003) using noncontingent reinforcement with tangible items. We showed that the effects of noncontingent music may continue during extended application and that varying music may be effective when a preferred song no longer reduces engagement in vocal stereotypy.

Some limitations should be considered when interpreting the results of the current study. The results of the comparison between noncontingent music and DRA is limited insofar as we chose to use edibles rather than music as reinforcers during DRA for all but one participant because the former are more practical to deliver in applied settings. The differential effects may have thus been the results of the different stimuli. The clinical relevance of using DRA with music would be limited given the complexity of its implementation. We thus preferred comparing two interventions which could be realistically implemented by educators and parents in applied settings. Similarly, we selected the densest schedules of reinforcement that could be practically applied in the participants' environments. Selecting denser schedules may have produced more desirable effects, but would have been challenging to implement for caregivers. In the third experiment, we did not conduct a no-prompting baseline, which limited the analysis of the unique contribution of prompting. Although a comparison of results across experiments and studies suggest that adding prompts had beneficial effects, the lack of an experimental design precludes definite conclusions. To minimize confounding effects associated with wearing headphones, we played the music through external speakers, which may be disruptive to others. In clinical practice, we would recommend that the individual wears headphones instead (Saylor et al., 2012).

Future research should replicate our study by evaluating the effects of the proposed sequential intervention model with a group of participants. Examining the unique contribution of prompting on stereotypy and appropriate behavior when noncontingent music or DRO produces undesirable collateral effects may also extend research while potentially improving treatment. Researchers should also consider conducting studies in which educators and caregivers apply the procedures and measuring social validity. Larger scale studies comparing the cost effectiveness as well as the effects of interventions designed to reduce vocal stereotypy when applied by individuals who are not trained in behavior analysis may also be crucial in the long term. In the end, programs that facilitate the selection and implementation of interventions by practitioners with different training backgrounds may produce the largest impact on the treatment stereotypy in individuals with autism and other developmental disabilities.

Acknowledgments

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